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Transoral Laser Microsurgery +/- Adjuvant Therapy versus Chemoradiotherapy for Stage III and IVA Oropharyngeal Squamous Cell Cancer: A Preliminary Comparison of Early Swallowing Outcomes.

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Abstract

Methods- In this preliminary, non-randomized study, patients with stage III and IVA oropharyngeal carcinoma treated with transoral laser microsurgery (TLM) were assessed pre-treatment and three months following treatment using the MD Anderson Dysphagia Inventory (MDADI), the Performance Status Scale (PSS) and a timed water swallow test (WST). Comparisons were made with an **historical** CRT cohort.

Results- Based on patients with measurements at both times, the decrease in score between baseline and 3 months was greater for CRT **patients** (n=26-28) than for TLM (n=20-21) **patients** for each of MDADI, PSS and WST. A repeated measures analysis that looked at all three scores simultaneously and allowed for missing values gave mostly similar results (except for MDADI).

Conclusions- TLM **was associated with** good **early** swallowing outcomes at 3 months and may offer a benefit over CRT. The results should be viewed as preliminary data, providing useful reference for any proposed controlled trial.

Introduction

The management of oropharyngeal squamous cell carcinoma (OPSCC) is a hotly debated topic. The increased survival noted with concurrent chemoradiotherapy (CRT), over radiotherapy alone, along with the recognition that traditional open surgical approaches were associated with greater morbidity¹ led to an ever increasing trend towards primary non-surgical treatment for these patients. However, the realisation that CRT is associated with greater long term morbidity than radiotherapy alone, the popularisation of Transoral Laser Microsurgery (TLM) and Transoral Robotic Surgery (TORS) and the recognition of a distinct population of patients with OPSCC caused by Human Papilloma Virus (HPV), has rekindled the debate. The incidence of HPV **positive** OPSCC now outweighs that of HPV **negative** disease in some areas of the world. The prognosis from HPV **positive** OPSCC is better than HPV **negative** disease and the survival following treatment appears roughly similar when taken from distinct non-surgical and surgical trials^{2,3}.

With the improved prognosis for HPV **positive** OPSCC patients has come the question of survivorship. These patients tend to be younger, generally medically fitter, non-smokers and work. Swallowing is a top priority concern for head and neck cancer survivors⁴. Furthermore, younger patients report more severe swallowing difficulties than older patients⁴. Whilst the issue of post-treatment function is clearly of huge importance, the literature does not allow a straightforward assessment of the outcomes following different treatment options.

How can we maximise functional outcome whilst maintaining survival prognosis? Advocates of TLM and TORS claim that swallowing is improved with these methods; patients with low volume disease (T1 and T2), N0 or N1 neck disease, clear surgical margins and no extracapsular spread are candidates for single modality surgery. However, this group of patients forms roughly 25% of OPSCC patients and would be candidates for radiotherapy alone rather than CRT. Surgery allows accurate staging of the disease, enabling reduced doses of adjuvant radiotherapy, with or without

chemotherapy, and potential reduction in the radiotherapy fields, particularly for lateralised OPSCC tumours. Advocates of CRT cite the greater level of evidence in support of its survival efficacy and the potential benefits of Intensity Modulated Radiotherapy (IMRT), although there is no published research directly comparing swallowing outcomes for IMRT and conventional (C)RT. In mixed treatment groups, larger radiation fields, accelerated fractionation and the addition of chemotherapy were associated with worse swallowing⁵⁻⁷.

Following a number of patients who suffered particularly severe functional morbidity following primary CRT, with negligible improvement in the first year following treatment⁸, this unit opted to move to offer primary TLM for patients with OPSCC. The initial aim of this study was to analyse swallowing outcomes in both TLM and CRT groups. However, analysis revealed that very few patients with surgically appropriate disease received CRT and over the period in question primary CRT was mainly given to T4 tumours. **Early** swallowing function following TLM has therefore been compared with an historic cohort of stage-matched patients undergoing non-surgical treatment and who received the same prospective swallowing evaluation.

The primary aim of this **preliminary, non-randomized** study was to assess the change in **early** swallowing function from baseline to 3 months following treatment between the TLM and **historical** CRT groups. Specifically, patients with stage III and IVA⁹ disease have been included. These stages represent tumours that merit treatment with chemoradiotherapy and are resectable via TLM surgery. Previous work indicates that while some improvement **in swallowing** does occur after 3 months **the improvement is small. Longitudinal studies have shown that** swallowing at 3 months is a very strong indicator of likely longer term function^{5,6,8}.

Materials and Methods

Patients presenting to the Sunderland Royal Hospital head and neck multidisciplinary team meeting with primary **resectable** stage III and IVA squamous cell carcinoma of the oropharynx from August

2011 until March 2013 were treated with TLM surgery and adjuvant therapy. **This was not a trial of the technique, but more a change in policy by the team away from CRT. All patients undergoing TLM were included in a prospectively collected database.** Swallowing is a multi-dimensional construct, and assessments from different domains can give differing results. Therefore, three outcomes were collected: a swallowing questionnaire, a clinician-rated dietary texture scale and a timed water swallow test, as detailed below. Data were collected at baseline, which will have occurred shortly after diagnostic biopsies, and at 3 months following completion of all therapy. Functional outcomes were then compared against a historical non-surgical case series recruited for a previous study⁸. All patients with stage III and IVA disease of the oropharynx were extracted from this research database. These included some patients receiving radiotherapy alone, for various reasons. Routine HPV testing was only performed for the TLM group, comprising p16 immunohistochemistry and when this was positive, in-situ hybridisation for high risk HPV¹⁰.

Treatment - TLM

Surgical resection of the primary tumour was performed as previously described in the literature¹¹.

The FK retractor (Olympus UK) was used for access and under microscopic visualisation the tumour was resected using the CO₂ Laser aiming for a macroscopic surgical margin of 1cm. In most instances, resection proceeded as recommended by Steiner and Ambrosch¹²; transecting the tumour mass to assess depth. Following what was deemed adequate resection, separate marginal specimens were resected to aid in confirmation of complete clearance. Specimens were pinned on corkboards and orientated with diagrams. Routine frozen sections were not used. Ipsilateral selective neck dissections were performed for lateralised tumours and bilateral selective neck dissections performed for midline disease. Initially, neck dissection was performed 2 weeks after TLM to the primary site as described. However, following a mortality due to haemorrhage 5 days post-operatively, following hospital discharge and presumed to arise from the resection site, this

practice was altered. Neck dissection is now performed simultaneously to resection of the primary site, to allow ligation of the feeding external carotid artery branches in an attempt to reduce this risk.

Post-operative radiotherapy was administered at a dose of 60-65Gy for two or more pathologically involved neck nodes and post-operative concurrent CRT (weekly cisplatin at 30-40mg/m²) was initiated in patients with pathologically involved primary site margins or extra-capsular spread within the resected lymph nodes.

Treatment – CRT cohort

The radiotherapy regime was 63Gy in 30 fractions over six weeks using 3D conformal techniques. This was combined with either Cisplatin 40mg/m² in six cycles or Mitomycin C 15mg/m² in two cycles. Patients were recruited from two North-East of England hospitals and treated at a single centre between 2006 and 2008.

Functional Outcomes

Patient rated swallowing outcomes were collected at baseline prior to treatment and at three months post treatment completion (including adjuvant therapy in the surgery group) using the MD Anderson Dysphagia Inventory (MDADI). **This self-report questionnaire has proven reliability and validity, and is sensitive to changes over time**^{4, 8, 13}. It has twenty items each with a five point response scale and can be summarised using a total score (range 20-100). A score of ≥80 indicates minimal or no swallowing problems.

Dietary texture restrictions were **clinician** rated using the Normalcy of Diet scale, which is a **single item** sub-section of the Performance Status Scales (PSS) **and can be marked independently. The PSS**

has good reliability and validity as well as sensitivity to differences in performance and change over time^{8, 14}. The scale has ten ranked categories ranging from 0 (nil by mouth) to 100 (full diet without restrictions).

Swallow performance was assessed using the timed 100mL Water Swallow Test (WST)¹⁵. Patients were instructed to swallow 100mLs of liquid "as quickly as is comfortably possible" and from this, a measure of swallow capacity (mLs per second) was calculated, **with a lower score indicating a poorer outcome**. The test was not performed if the patient reported choking on fluids and was scored as a zero. **The test has good reliability and validity and is sensitive to measuring change over time and differentiating between treatment outcomes**^{8, 16, 17}

Statistical Analysis

Both parametric (repeated measures) and non-parametric analyses were performed to compare the change in swallowing scores between baseline and 3 month follow up between the two groups (TLM and CRT). The **multivariate** repeated measures analysis, **conducted using the GLM Repeated Measures option in SPSS**, looked at changes in all three scores simultaneously and **adjusted for missing values via multiple imputation, allowing for the fact that all scores lie between 0 and 100**. **This analysis** was based on the assumption that the scores are normally distributed. However, due to the construction of the MDADI and PSS questionnaires, the assumption of normality is questionable; for instance, a difference of 10 on the MDADI score between 90 and 80 may not compare to the clinical difference of 10 between 50 and 40 on the same scale. **Furthermore, as highlighted below, the scores have skewed distributions**. Consequently, when considering each score in turn, Mann-Whitney U-tests were used to look for differences in the change in score between groups, **based on those patients with measurements at both baseline and 3 months**. **Particular attention was given to p-values less than 0.05**. Analyses were performed using SPSS version 19.

Ethical Considerations

Formal local research ethics committee approval was obtained for the original chemoradiotherapy group. Subsequently the collection of the three swallowing outcomes has become routine practice in this department. Approval was obtained from the Sunderland Royal Hospital clinical governance department to collect the data.

Results

Twenty-three patients treated with TLM and thirty-three patients treated with primary non-surgical management, with complete demographic and tumour staging data, were included **in the** analysis.

Every consecutive patient undergoing TLM within the study timeframe has been included in the descriptive results. Ninety-four percent of patients in the historical non-surgical cohort agreed to take part in the data collection. Twenty-nine of the non-surgical group were treated with concurrent chemoradiotherapy. All 33 will be referred to as the CRT group. The characteristics of each group are summarised in table 1. Unfortunately, at the time that data were collected for the historic CRT cohort, nodal status was classified as N2 disease and was not sub classified further.

Nineteen patients in the TLM group had tumours deemed to be HPV positive.

Adjuvant therapy was given to 21 of the TLM patients; 17 receiving radiotherapy alone and 4 receiving chemoradiotherapy. One of these four patients had adjuvant chemoradiotherapy for positive margins the other three for nodal extracapsular spread (ECS). Two patients refused the addition of chemotherapy for ECS.

Some missing data occurred in 4 of the TLM group; as detailed above, one patient died of a post-operative haemorrhage, one failed to attend for follow-up and failed to complete all questionnaires,

and the absence of two PSS Normalcy of diet scores was an accidental scoring omission. Seven patients in the CRT had missing data due to post-treatment mortality (n=1), persistent disease preventing collection of data (n=2), mental health concerns (n=1) and three failed to attend follow-up or return postal questionnaires (n=3). The numbers of patients with complete data for each swallowing outcome are detailed in table 2 and vary from 20 to 21 for the TLM group and 26 and 28 for the CRT group.

The mean and standard deviations for pre- and 3-month post treatment swallowing scores are summarised in table 2, separately for the TLM and CRT groups. Only patients with both pre- and 3-month scores have been included here. Based on a Mann-Whitney U-test for patients with both pre- and 3-month scores, there was no significant difference in baseline scores between the two groups for MDADI scores (p=0.078), PSS Normalcy of diet (p=0.51) nor WST (p=0.55). However, when all patients (including those with missing data) were included in this calculation, there was a significant difference in baseline scores on the MDADI between the two groups (p=0.012), but less evidence of a difference for PSS Normalcy of diet (p=0.082) and no evidence of a difference for WST (p=0.43).

There were a higher proportion of T3 primary tumours in the CRT group (13/33) than the TLM group (5/23). When T3 tumours were removed from the descriptive analysis, the CRT group had mean pre- and 3-month scores of 79.1 and 59.1 (MDADI), 76.4 and 36.0 (PSS Normalcy of diet) and 17.3 and 13.0 (WST). Relative to the entire CRT group, mean scores for T1-2 tumours were slightly lower in the case of MDADI and PSS Normalcy of diet and slightly higher in the case of WST.

Based on MDADI, seventy six per cent of the TLM group (16/21) and ninety-two percent of the CRT group (24/26) reported more swallowing problems following treatment, compared with their baseline score. Using a complete case analysis, the change in MDADI score between baseline and 3 months was greater for CRT than for TLM (p=0.029, Mann-Whitney U), indicating a poorer patient reported swallowing outcome for the CRT group. There was also evidence for a difference between the groups in the change in score for PSS Normalcy of diet (p<0.001, based on 9 out of 20 TLM and

25 out of 28 CRT patients with **lower PSS Normalcy of diet** scores at 3 months **than at baseline**) and WST ($p=0.034$, based on **10 out of 21** TLM and **20 out of 28** patients with **lower** WST scores at **3 months than at baseline**). The mean values of the scores at baseline and 3 months for TLM and CRT patients are depicted in figures 1-3 and again are limited to those patients with both pre- and 3-month data. In particular, figures 2 and 3 show that for PSS **Normalcy of diet** and WST **in particular**, the change in score between baseline and 3 months is more marked for the CRT patients than for the TLM patients, suggesting that the **former** group had a poorer swallowing outcome.

The mean (standard error, **effect size[mean difference / standard deviation]**) of the difference between the pre- and post-treatment measurements, based on those patients with both measurements, were: 11.7 (3.8, **0.66**) and 22.3 (3.3, **1.31**) for the MDADI scores in the TLM ($n=21$) and CRT ($n=26$) groups respectively, 8.5 (4.4, **0.44**) and 47.1 (5.3, **1.69**) for the PSS **Normalcy of diet** in the TLM ($n=20$) and CRT ($n=28$) groups respectively, -0.1 (1.2, **-0.018**) and 5.3 (1.5, **0.68**) for the WST in the TLM ($n=21$) and CRT ($n=28$) groups respectively.

The **multivariate** repeated measures analysis **based on all of the patients** (assuming a normal distribution for the scores and **using multiple imputation for the missing scores**) found evidence for a difference between TLM and CRT in the change in score for PSS **Normalcy of diet** ($p<0.001$) and WST ($p=0.03$), **but not for the MDADI** ($p=0.20$)

Five patients in the CRT group were unable to complete the WST due to high risk of gross aspiration at three months and scored zero. No patients in the TLM group and none in either group at baseline scored zero.

Discussion

This is the first study to assess swallowing function after primary TLM for OPSCC using 3 different swallowing measures and to compare these with a matched group of CRT patients. It follows the

methodology used by Patterson et al⁸ in analysing the swallowing outcomes with CRT for all head and neck cancer sites; the OPSCC cohort from this has formed the stage matched comparison group for this study. **The results of our preliminary, non-randomized study suggest** that patients treated by TLM had significantly better swallowing self-report outcomes, diet texture scores and swallow performance outcomes at three months following treatment than the matched CRT group. The differences in the results presented here may be attributable to decreased diffuse post-radiotherapy scarring. Fibrosis of the musculature reduces the efficiency, co-ordination and safety of the swallowing mechanism. It is a long-term condition, which can spread to surrounding tissues thus progressively reducing function. Although the current study reports early post-treatment outcomes, patients appear to be functioning at a **relatively high level** and maintaining muscular condition, which may reduce the likelihood of chronic dysphagia.

When assessing swallowing function it is important to realise that there is no single method of measuring outcomes. Patients' experiences do not always correlate with objective measures¹⁸. Therefore, both patient reported and clinician rated assessments were collected. These measures are routinely collected in our centre. The current study did not include any swallowing instrumentation, as this was rarely indicated from clinical assessment. No one in the TLM was unable to complete the WST, whereas **in the CRT group** five patients could not complete the WST due to overt aspiration.

These data make a valuable contribution to the evidence base on swallowing function following OPSCC. Comparing surgical and non-surgical therapy in the setting of a controlled trial is challenging. It was encouraging to read that the concept of a phase III RCT comparing transoral surgery with conventional CRT for OPSCC was discussed at a United States national cancer meeting in 2011¹⁹. Given that survival outcomes appear approximately similar, functional outcome is likely to be a primary outcome for such a trial. We believe that the combination of the MDADI, PSS

Normalcy of diet and WST offer a straightforward and reproducible method of capturing patient reported function and objective assessment in the clinical setting.

This study has deficiencies and the two groups may not be directly comparable. However, the results offer useful **preliminary** data for any RCT proposal. There appears to be a benefit in swallowing as measured by the PSS and WST with TLM and adjuvant therapy over **historical** CRT.

The benefits as measured by the MDADI are less clear but there does appear to be a **modest benefit** with TLM. Not all patients in each group completed all 3 swallowing measures at the 2 time points.

If a patient missed a test **either** pre-treatment or at follow up, this could not subsequently be rectified. **Using multiple imputation to allow for missing data gave broadly similar results, but relied on an assumption of normality in the scores that is questionable.**

The baseline difference between the two groups was significant for the MDADI, when all patients including those with missing data were analysed. The statistical methods used to analyse the results take into account baseline differences, but as mentioned earlier the MDADI is unlikely to be a uniform scoring system. A difference of 10, whilst deemed a clinically significant difference, may not be equivalent from a start point of 89 compared to 81. Why this baseline difference exists **in this current study** is interesting. Options include:

1. Small sample sizes and chance. The baseline MDADI scores for TORS and CRT in the recent study by More et al ²⁰ are equivalent and are more in line with the historic CRT cohort from this study.
2. Between 2006 and 2008, when the CRT patients were treated, TLM was not routinely offered in this centre. This may have led to more extensive diagnostic biopsies. Now, a biopsy that does not breach the tumour margins is recommended with TLM in mind. As baseline swallowing measurements were usually taken about 2 weeks after biopsy there may have been the potential for the biopsy sites to be more painful in the CRT group thus lowering swallowing scores.

3. There has been a rapid rise in HPV **positive** disease. It is possible that a greater proportion of TLM patients were HPV **positive** than the CRT group. HPV **positive** tumours are perhaps more discrete tumours, homogenous and unlikely to be present in surrounding epithelial field change, which may mean they cause less swallowing impairment.

4. **There was a higher proportion of advanced T-stage disease (T3) included in the historical CRT group (13/33) compared to the TLM group (5/23). This could have led to a worse swallowing performance in the CRT group at baseline. However our results do not support this suggestion for the MDADI or PSS.**

5. We must acknowledge the lack of N2 nodal sub classification in the CRT group. No patients with N2c disease were treated in the TLM group. It is difficult to conclude what effect the inclusion of patients with N2c disease in the CRT cohort would have had on the mean swallowing scores, other than to assume it would have worsened function. Clearly N2c disease would have been treated with full dose radiotherapy to both sides of the neck.

We do acknowledge a lack of comparative basic data between the two groups, eg. smoking status, alcohol consumption, co-morbidities. We also recognise that a follow-up period of three months may be considered short. However, as mentioned earlier, swallowing at 3 months is a strong indicator of future performance. This study was intended to offer preliminary data. No clinically significant difference was established with a view to performing a sample size calculation in advance. However, for the purposes of an RCT, we would consider a difference of 10 on the MDADI to be a clinically significant difference.

Irrespective of whether the 2 groups are directly comparable, it **seems apparent** that patients treated pragmatically with TLM +/- adjuvant therapy function well **with respect to swallowing** at 3 months post-treatment. If a score of 80 or more on the MDADI is considered to represent minimal or no swallowing problems, [4] then a mean score of 78 at 3 months for a group of stage III and IVA

OPSCC should be viewed positively. Likewise the lack of any reduction in the objective WST in this group is impressive. We accept that 2 out of 23 patients were treated with surgery alone and that only 4 had adjuvant chemoradiotherapy, but this is a pragmatic study and does represent the potential advantages of surgically staging the disease. This study is too small to make any meaningful conclusions on how surgery alone compares to TLM + RT and how this compares to TLM + CRT. These are questions that need addressing in the setting of an RCT and we hope that these data add to the planning of any such trial.

Attempting to form a conclusion on swallowing outcomes following OPSCC treatment from the current evidence is challenging. Studies examining swallowing outcomes tend to be single institution series, small in number, lacking in homogenous data collection time points and **employing** a variety of swallowing measures have been used. One of the clear criticisms of this study is that we have compared TLM versus conventional radiotherapy techniques and not IMRT. More et al²⁰ recently looked at the MDADI scores for 20 patients undergoing TORS + adjuvant therapy and 20 patients undergoing IMRT CRT for stage III and IVA OPSCC. Both groups had a baseline **MDADI** score of 78, in line with this study's CRT group. Swallowing was assessed at 3, 6 and 12 months, but for the TORS group the 3 month score coincided with adjuvant therapy whereas in our study we looked at 3 months following completion of all therapy. Our study's 3 month TLM results should therefore be viewed to be as equivalent time points to the 6 month scores in the study by More et al. Whereas the TORS group improved from an **MDADI** score of 62 at 3 months to 76 and 78 at 6 and 12 months respectively, the CRT group **MDADI** scores were 56 and 57 at 3 and 6 months, rising to 60 at 12 months. The **MDADI** scores at 6 and 12 months statistically favoured the TORS group. It is therefore evident that the conventional RT techniques used in our study led to very similar results to those of IMRT (59 and 56 respectively). However, at a recent meeting, Roe et al²¹ did present slightly more encouraging results with IMRT techniques for primary CRT for OPSCC; **among** 62 patients of all stages and all head and neck sites (but as with most series, predominantly stage III and IV OPSCC), the MDADI score **rose** to approximately 70 at 12 months post treatment.

Conclusions

This study should be regarded as providing preliminary data. It **suggests** a benefit in swallowing self-report outcomes, diet texture scores and swallow performance outcomes at three months following treatment with TLM +/- adjuvant therapy compared to the **non-randomized historical** CRT group.

This adds to emerging evidence that primary transoral surgery offers a benefit in swallowing function over primary CRT. However, only a sufficiently powered RCT will truly answer this question.

This study may help provide the template for swallowing assessment and data to aid in planning of such a trial.

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Table 1. Patient demographics

Demographic		TLM (number =23)	CRT (number =33)
Mean Age (SD)		59.3 (8.6)	59.3 (8.6)
Gender: Male		17	26
Female		6	7
Site of Tumour			
Tonsil		15	18
Base of Tongue		7	11
Posterior Pharyngeal Wall		1	2
Soft Palate		0	2
Overall Stage			
III		5	13
IVA		18	20
T Classification	N Classification		
T1		(n=5)	(n=5)
	N2		5
	N2a	1	
	N2b	4	
		(n=13)	(n=15)
T2			
	N1	2	7
	N2		8
	N2a	2	
	N2b	9	
T3		(n=5)	(n=13)
	N0	2	2
	N1	1	4
	N2		7
	N2a	1	
	N2b	1	

TLM = Transoral Laser Microsurgery, CRT = Chemoradiotherapy
SD = Standard Deviation

Table 2. Pre – and 3-month post treatment swallowing scores for patients with both scores.

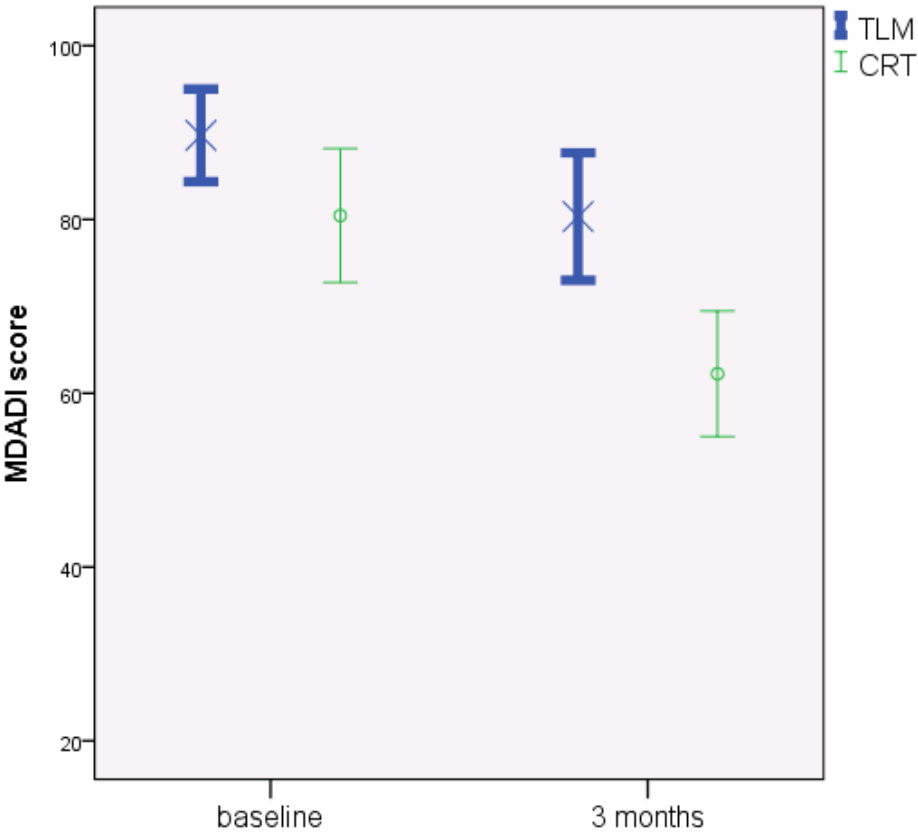
Swallowing score	TLM Mean (SD) [number=] (Median, Interquartile range)	CRT Mean (SD) [number=] (Median, Interquartile range)
Pre- MDADI	89.7 (11.7) [n=21] (93.7, 76.8-100)	81.4 (17.2) [n=26] (76.8, 64.7-99.7)
3 month MDADI	77.9 (14.4) [n=21] (77.9, 69.5-88.4)	59.1 (17.1) [n=26] (57.9, 47.4-73.7)
Pre- PSS	93.5 (16.6) [n=20] (100, 100-100)	88.9 (21.8) [n=28] (100, 55-100)
3 month PSS	85.0 (21.9) [n=20] (90, 85-100)	41.8 (32.8) [n=28] (40, 10-50)
Pre- WST	18.5 (8.2) [n=21] (16.6, 10.8-25.0)	16.8 (7.5) [n=28] (14.3, 11.1-22.5)
3 month WST	17.9 (7.1) [n=21] (18.6, 12.2-25.0)	11.4 (9.0) [n=28] (11.1, 2.0-19.2)

TLM = Transoral Laser Microsurgery, CRT = Chemoradiotherapy

MDADI = MD Anderson Dysphagia Inventory, PSS = Performance Status Scale Normalcy of Diet

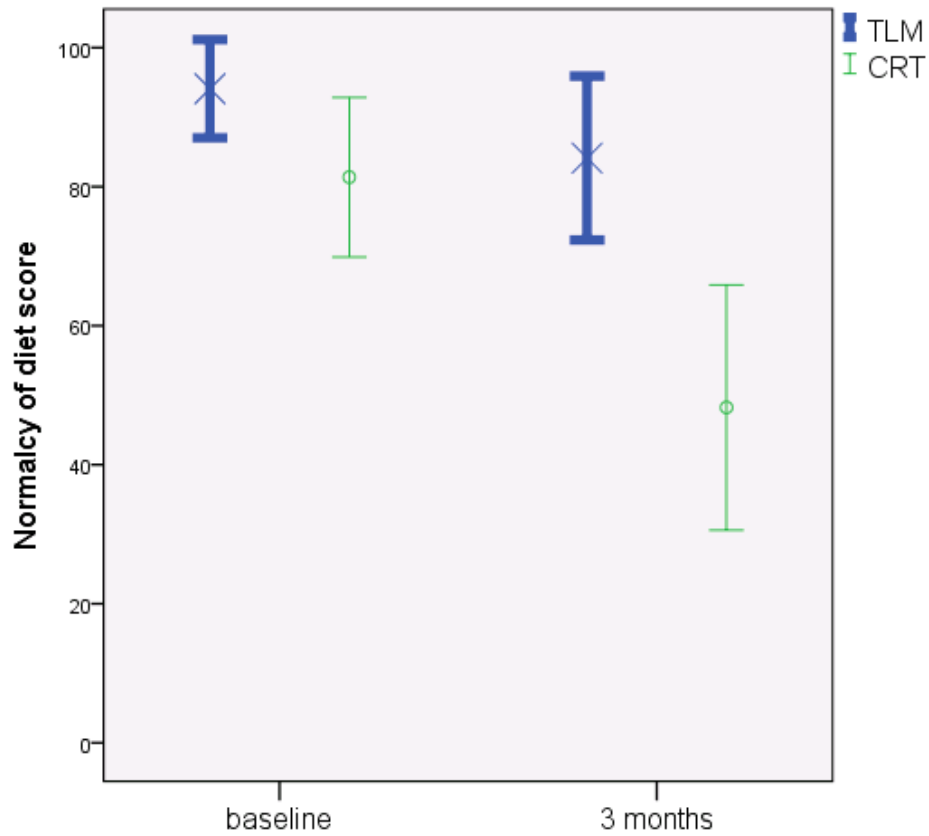
WST = Water Swallow Test

Figure 1 Mean MD Anderson Dysphagia Inventory scores and 95% confidence intervals (error bars) for patients with observations at both baseline (pre-treatment) and 3 months



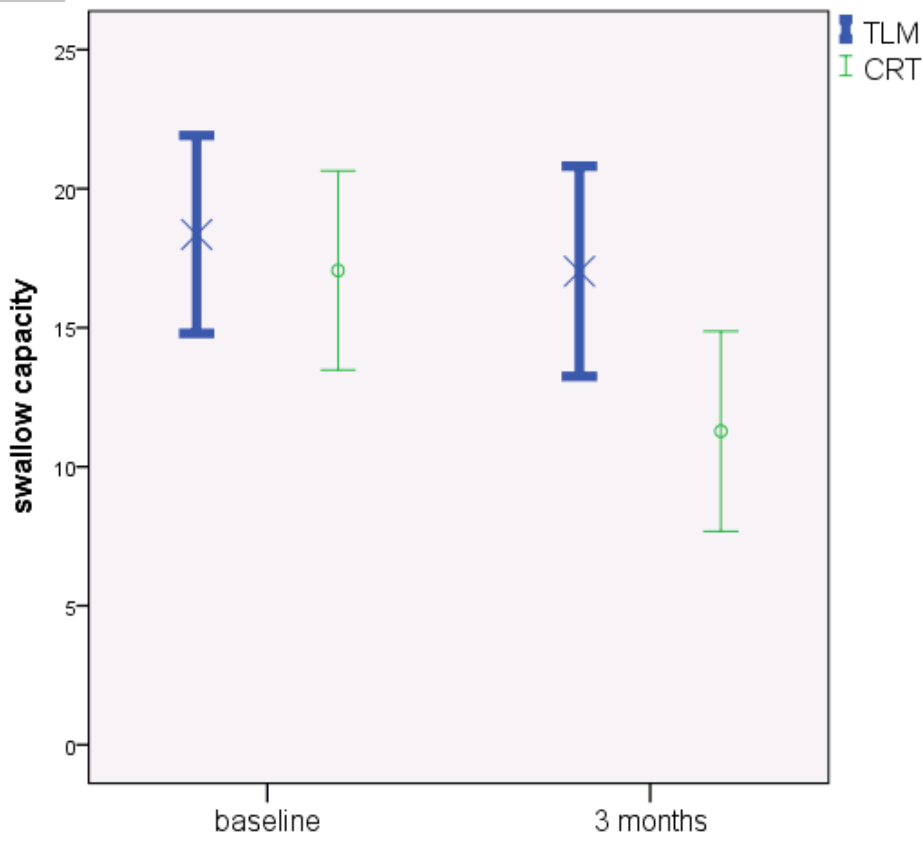
TLM = Transoral Laser Microsurgery, CRT = Chemoradiotherapy
MDADI = MD Anderson Dysphagia Inventory

Figure 2 Mean Performance Status Scale - Normalcy of diet scores and 95% confidence intervals (error bars) for patients with observations at both baseline (pre-treatment) and 3 months



TLM = Transoral Laser Microsurgery, CRT = Chemoradiotherapy

Figure 3 Mean swallow capacity (Water Swallow Test) scores and 95% confidence intervals (error bars) for patients with observations at both baseline (pre-treatment) and 3 months



TLM = Transoral Laser Microsurgery, CRT = Chemoradiotherapy